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8 March 1977

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UNEP Meeting of experts designated by Governments, Intergovernmental and Non-Governmental Organizations on the Ozone Layer

Washington, D.C., 1-9 March 1977

REPORT ON THE MEETING

Na.77-1010

REPORT OF THE UNITED NATIONS ENVIRONMENT PROGRAMME MEETING OF EXPERTS DESIGNATED BY GOVERNMENTS, INTERGOVERNMENTAL AND NON-GOVERNMENTAL ORGANIZATIONS ON THE OZONE LAYER, WASHINGTON, D. C., 1-9 MARCH 1977

1. Opening of the Meeting

The meeting was opened by the Chairman, Dr. David A. Munro, Special Advisor to the Executive Director of the United Nations Environment Programme, at 10:45 AM on 1 March 1977 in the Loy Henderson Conference Room, at the Department of State, Washington, D. C.

On behalf of the Department of State of the United States of America Mr. Lindsay Grant, Deputy Assistant Secretary for Environmental and Population Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, offered a warm welcome to Dr. Mostafa K. Tolba, the Executive Director of the United Nations Environment Programme.

In his opening address Dr. Tolba welcomed the delegates to the meeting, thanked the Government of the United States for acting as host to the meeting and acknowledged the continuing support given to UNEP by the United States.

Dr. Tolba recalled the decision of the Governing Council which called for the meeting and went on to review the significance of the natural ozone layer and the possibility of its modification by man.

UNEP's concern with outer limits, especially as it related to dangers to the ozone layer, was explained and Dr. Tolba noted the high priority given to this global pollution problem within the outer limits programme. He said that in close cooperation with the specialized agencies, a thorough state of the art review covering the natural and perturbed

stratosphere and the possible consequences for mankind, should be undertaken. This would enable identification of necessary action by governments individually or jointly.

In reply to Dr. Tolba's opening address, Dr. Robert M. White of the National Oceanic and Atmospheric Administration, speaking on behalf of the Government of the United States of America, expressed his pleasure with the UNEP decision to convene the meeting on the ozone layer in the United States and extended a welcome to the participants on behalf of the United States Government. He cited the complexity, pervasiveness, and global scope of environmental issues raised by contamination of the ozone layer as factors that make meetings such as this so vital. Only through such meetings can the international scientific community form an assessment of our understanding of the problem and what must be done to help solve the problem. He indicated that he views UNEP's role as catalyst and coordinator in dealing with this global environmental problem as not only appropriate and significant but perhaps critical.

Dr. White stressed that only through science can we understand and predict the future consequences of human actions on the protective ozone layer. The hazards involved are universal, and the causes are widely dispersed throughout the world. Clearly, the problem and its resolution are of concern to all nations. He expressed his hope that this attempt by UNEP to further scientific understanding through international exchange of ideas would help to determine the relative importance of various projects and more clearly define priority actions, would provide guidance on what should be done by specific nations and

international agencies, and would indicate where coordination of the work of several participating agencies and nations is most necessary.

2. Participants of the Meeting

(a) Representatives of Governments

Australia,	Belgium,	Bolivia,
Canada,	Central African Empire,	China
Democratic People's Republic of Korea,	Denmark,	Egypt,
Federal Republic of Germany,	Finland,	France,
Guatemala,	India,	Italy,
Ivory Coast	Libyan Arab Republic,	Netherlands,
Nicaragua,	Norway,	Phillippines,
Republic of Korea,	Sweden,	Switzerland,
Thailand,	Togo,	Uganda,
USSR,	United Kingdom	United States of America,
Uruguay,	and Venezuela	

(b) United Nations Bodies

Department of Economic and Social Affairs of the United Nations

United Nations Institute for Training and Research

(c) Representatives of Specialized Agencies

The Food and Agricultural Organization

International Civil Aviation Organization

The World Health Organization

United Nations Educational Scientific and Cultural Organization

The World Meterological Organization

(d) Representatives of Intergovernmental Organizations

European Economic Community

(e) Representatives of Non-governmental Organizations

International Chamber of Commerce

International Council of Scientific Unions/Scientific Committee on Problems of the Environment ICSU/SCOPE

3. Agenda

The meeting approved the agenda as given in Annex 1 to this report.

4. Documentation

A number of basic and background papers relating to various aspects of the ozone layer were placed before the meeting by experts designated by Governments, United Nations bodies, Specialized Agencies and Non-governmental Organizations.

A list of these documents is given in Annex II to this report.

The documents listed in Annex II were presented at the meeting by representatives of governments, United Nations bodies, specialized agencies and non-governmental organizations. The reports of research activities in various countries and the views expressed by the specialized agencies and other organizations were considered by the meeting and used to prepare the overview of environmental aspects of stratospheric ozone depletion that appears below under Agenda items 3 and 4.

Agenda Item 3: Review of the Risk to the Ozone Layer and Possible Effects on Mankind.

Agenda Item 4: Ongoing and Planned Activities (Contributions from Agencies, Governments and Other Bodies)

The existence of the Earth's ozone layer and its vital importance to life on this planet have been known for many years. It is also known that man evolved and adapted over millions of years, to a particular level of ozone in the atmosphere. But only recently has it been realized, that some of man's activities could lead to stratospheric pollution and to a significant reduction in ozone amounts, in a few decades.

It is now generally accepted that a wide variety of naturally occurring and man-made substances can lead to changes in the ozone layer, although most of these effects are small and difficult to identify.

At the meeting, the World Meteorological Organization reported on its actions and proposals, some undertaken in cooperation with UNEP, to determine the state of the natural ozone layer and its modification by man's activities. Among the possible ozone depleting substances, particular attention has been given to the nitrogen oxide emission of aircraft and to the emissions of chlorofluoromethanes (CFMs).

There was a large measure of agreement that depletion of the ozone layer by current aircraft emissions is probably negligible, but that CFM emissions are a matter of concern. Taking into account all presently known factors, the National Academy of Sciences has provided estimates of long-term ozone depletions from continued CFM emissions at the 1973 level of near 8% with an uncertainty range from 2% to 20%. Several representatives expressed reservations with these estimates, referring to the possibility of still unknown and unaccounted for factors.

The depletion role of natural events such as volcanoes and solar activity and other of man's activities such as nuclear explosions and the use of nitrogen fertilizer are not sufficiently well understood and will have to be studied within the proposed research and monitoring programme.

Concern over depletions in the ozone layer arises from the danger of increased penetration of the atmosphere by damaging wavelengths of the sun's ultraviolet radiation (UV-B) which could have deleterious effects on man and the biosphere and possible climatic effects.

The World Health Organization reported that the effects of chronic exposure to increased solar UV would be insidious and could result in accelerated skin aging and in increased incidence of skin cancer, but emphasized that all presently available quantitative estimates of the effects are subject to great uncertainty.

The Food and Agriculture Organization reported that any threat to plant productivity, no matter how subtle, is of concern in view of the existing global demands for food and fiber production, but that it is presently impossible to predict the magnitude of the effect on plant life due to any particular stratospheric ozone reduction. The representative of ICSU noted the complexity of the effects of UV-B radiation on living organisms and urged that research on photobiology receive greater attention.

The Department of Economic and Social Affairs of the United Nations reviewed available information on production of CFMs and indicated how, with more data and some elaboration of methodology, it might be possible to develop a useful cost/benefit analysis of the various options for regulating the use of ozone-damaging substances.

The representative of the International Chamber of Commerce reported on the relevant research in universities being supported by the Manufacturing Chemists Association.

The reports of countries reflected the fact that much of the research, measurement and monitoring related to the ozone layer is being undertaken at the national level. Research related to atmospheric physics and chemistry, numerical modelling, and the measurements of trace species was outlined in some detail and reviews were given to a variety of efforts in the human and biological areas.

The presentations of nations and organizations emphasized that considerable progress has been made in our understanding of the ozone depletion mechanism and the consequences for man, but stressed the need for overall coordination and for support of the necessary monitoring and research activities to increase man's knowledge of this vital part of his global environment.

The review enabled the meeting to define gaps and make recommendations for a World Plan of Action on the Ozone Layer which is given in Annex III to the report.

Agenda Item 5: Recommendations

The recommendations of the meeting are included in the World Plan of Action on the Ozone Layer under the following sections:

1. The Natural Ozone Layer and its Modification by Man's Activities.

2. The Impact of Changes in the Ozone Layer on Man and the Biosphere.

3. Socio-economic Aspects.

Priorities

The actions recommended under each of the above-mentioned sections and sub-sections are those that the meetings considered to be of highest priority.

Distribution of Work

The World Plan of Action on the Ozone Layer indicates, by means of an addition between brackets to each particular action, the acronym of that

organization which will assume the leading role in carrying out that action, followed by the cooperating organizations. Where cooperating organizations are not listed the lead organization will make appropriate arrangements for cooperation.

Coordination Mechanism

The recommendations of the meeting for the coordination mechanism are included in Section 4 of the World Plan of Action on the Ozone Layer under the title, "Institutional Arrangements".

Others

The meeting did not discuss actions to control emissions into the atmosphere of potential ozone damaging substances. However, it considered that it would be desirable to investigate all possible methods for such control and their consequences.

Agenda Item 6: Adoption of the Report

The meeting adopted this report.

The Chinese participants stated that in view of the fact that they need to further study the report and its various recommendations, including the recommendation of the WMO, the Chinese Delegation cannot make any commitments to the report and the recommendations contained therein.

Agenda Item 7: Closing of the Meeting

The Chairman in closing the meeting expressed once again the gratitude of UNEP to the Government of the United States for having hosted this meeting and for having provided the excellent facilities which enabled the meeting to conduct its work successfully.

Annexes -

I - Agenda for the Meeting

II - List of Documents for Ozone Meeting

III - World Plan of Action on the Ozone Layer.

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Annex I
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Washington, D.C., 1-9 March 1977

AGENDA FOR THE MEETING

1. Opening of the meeting.

2. Adoption of the agenda.

3. Review of the risk to the ozone layer and possible effects on mankind.

4. Ongoing and planned activities (contributions from agencies, Governments and other bodies).

5. Recommendations:

   (a) Priorities;

   (b) Distribution of work;

   (c) Co-ordination mechanism;

   (d) Others.

6. Report of the meeting.

7. Closure of the meeting.

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ANNEX II
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8 March 1977
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UNEP Meeting of experts designated by Governments, Intergovernmental and Non-Governmental Organizations on the Ozone Layer

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LIST OF DOCUMENTS FOR OZONE MEETING

1 BASIC DOCUMENTS

SYMBOL	SUBMITTED BY	TITLE
UNEP/WG.7/1	-	AGENDA
UNEP/WG.7/2	-	TIMETABLE
UNEP/WG.7/3 UNEP/WG.7/3(ABS)	ICAO	Aircraft engine emissions
UNEP/WG.7/4 UNEP/WG.7/4 ERRATA UNEP/WG.7/4 (ABS)	WHO	Effects of UV radiation on human health
UNEP/WG.7/5 UNEP/WG.7/5(ABS)	WMO	Atmospheric Ozone. A survey of the current state of knowledge of the ozone layer.
UNEP/WG.7/6 UNEP/WG.7/6(ABS)	UN/ESA	Economic and Social Implications of a possible ban on the use of fluorocarbons.
UNEP/WG.7/7 UNEP/WG.7/7(ABS)	FAO	Effects of changing levels of UV radiation on plant and timber production

UNEP/WG.7/8 UNEP/WG.7/8(ABS)	OECD	Assessment of the economic impact of restrictions on the use of fluorocarbons
UNEP/WG.7/9 UNEP/WG.7/9(ABS)	FAO	Effects of changing levels of UV radiation on phytoplankton
UNEP/WG.7/10 UNEP/WG.7/10 ERRATA UNEP/WG.7/10 (ABS)	UNEP	Environmental Aspects Stratospheric Ozone Depletion
UNEP/WG.7/11 UNEP/WG.7/11 ERRATA UNEP/WG.7/11 (ABS)	CANADA	Stratosphere and ozone research activities in Canada
UNEP/WG.7/12 UNEP/WG.7/12(ABS)	USA	US investigations to evaluate the potential threat of stratospheric ozone diminution.
UNEP/WG.7/13 UNEP/WG.7/13(ABS)	BELGIUM	Sur l'etude des problemes de l'ozone atmospherique en Belgique.
UNEP/WG.7/14 UNEP/WG.7/14(ABS)	ICC	The effects of fluorocarbons on the concentration of atmospheric ozone.
UNEP/WG.7/15	SWEDEN	Swedish research related to the stratospheric ozone problem.
UNEP/WG.7/16	DENMARK	Danish research activities related to the halocarbon-ozone problem - 1977
UNEP/WG.7/17 UNEP/WG.7/17(ABS)	NORWAY	Survey of Ozone Research in Norway
UNEP/WG.7/18 UNEP/WG.7/18(ABS)	FEDERAL REPUBLIC OF GERMANY	Statement of the Federal Republic of Germany delegation concerning research in the field of the stratospheric ozone layer.
UNEP/WG.7/19 UNEP/WG.7/19(ABS)	FRANCE	Programme Francais de recherche sur l'ozone stratospherique

UNEP/WG.7/20 UNEP/WG.7/20(ABS)	UNITED KINGDOM	Studies on the stratosphere and the possible effects of stratospheric pollution.
UNEP/WG.7/21 UNEP/WG.7/21 ERRATA UNEP/WG.7/21 (ABS)	ITALY	A Report to UNEP on Atmospheric Research activities in Italy.
UNEP/WG.7/22	SWITZERLAND	Contribution of Switzerland to the WMO ozone research and monitoring programme.
UNEP/WG.7/23 UNEP/WG.7/23 ERRATA UNEP/WG.7/23 ERRATA/Rev.1 UNEP/WG.7/23 (ABS)	UN/ESA	Ozone layer and development.
UNEP/WG.7/24 UNEP/WG.7/24 ERRATA	NETHERLANDS	Review of research activities related to dangers to the ozone layer.
UNEP/WG.7/25 UNEP/WG.7/25/Rev.1	UNEP	Report on the Meeting
UNEP/WG.7/26 UNEP/WG.7/26 (ABS)	AUSTRALIA	Australian Position Paper Outlining Current Monitoring and Research Being Carried out into Stratospheric Ozone and Related Subjects

II BACKGROUND PAPERS

UNEP/WG.7/Background 1 UNEP/WG.7/Background 1/ERRATA	ICSU/SCOPE	Stratospheric Ozone depletion. An environmental impact assessment.
UNEP/WG.7/Background 1/Add.1 UNEP/WG.7/Background 1/Add.1(ABS)		ICSU activities in the field of stratospheric ozone, in cluding possible geophysical and biological consequences of ozone depletion.
UNEP/WG.7/Background 2	University of Toronto Institute for environmental studies	Atmospheric exchange processes and the ozone problem.

III INFORMATION DOCUMENTS

UNEP/WG.7/INF 1	General Information Document
UNEP/WG.7/INF 2	General Information Document
UNEP/WG.7/INF 3/Rev.3	List of Participants
UNEP/WG.7/INF 4/Rev.5	List of Documents
UNEP/WG.7/INF 5	Functional Directory
UNEP/WG.7/INF 6	Documentation

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ANNEX III
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UNEP Meeting of experts designated by Governments, Intergovernmental and Non-Governmental Organizations on the Ozone Layer

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WORLD PLAN OF ACTION ON THE OZONE LAYER

World Plan of Action on the Ozone Layer

1. The Natural Ozone Layer and its Modification by Man's Activities

The natural stratosphere and its ozone layer have been the subject of extensive research over the last fifty years. The need for jet aircraft to fly at high altitudes has long spurred the interest of the world's meteorological community. The curiosity of atmospheric physicists and chemists has provided the main thrust to illuminate the dynamics and photochemistry of the ozone layer.

In recent years research, associated with the accelerating pace of man's activities in the stratosphere and space, has greatly modified our perception of ozone photochemistry. It is widely accepted that natural ozone photochemistry is controlled to a large extent by the action of nitric oxide derived from nitrous oxide which emanates from the earth's surface as a result of denitrification processes. This has added a new dimension to the ozone problem and new interest in studies of the earth's nitrogen cycle. It is now thought that stratospheric ozone is influenced by a variety of naturally occurring substances such as methane and methyl chloride. A continuing long-term programme is essential to our further understanding of these natural phenomena and as a basis for evaluating new effects.

Quite recently the impact of other substances such as the nitrogen oxides from aircraft exhausts and the man-made chlorofluoromethanes (CFMs) has been receiving intense scrutiny. As these are all trace substances with atmospheric concentrations as low as a fraction of a part per billion, the problems of measurement, analysis and modelling have changed by an order of magnitude from those encountered when our understanding was based on the

assumption of the simple Chapman (pure oxygen) system. Our knowledge and understanding have been greatly increased by a number of intensive national programmes, and there is a large measure of agreement on the model predictions that current aircraft emissions have minimal effects on the ozone layer but that the effects of continuing emissions of CFMs at the 1973 or higher levels are a matter of concern.

There are many known gaps in our knowledge of factors affecting the ozone layer, and there may be factors that are as yet unrecognized. An intensive and well coordinated monitoring and research programme related to the occurrence of trace substances in the atmosphere, to test the model predictions and narrow their range of uncertainty, is particularly important.

Recommendations:

The coordinated research and monitoring programme, already initiated by the World Meteorological Organization*, to clarify the basic dynamical photochemical and radiative aspects of the ozone layer and to evaluate the impact of man's activities on the ozone balance should be encouraged and supported.

Specifically this should include action to:

Monitor Ozone (WMO)**

1. Design, develop, and operate an improved system (including appropriate ground-based, airborne and satellite subsystems) for monitoring and prompt reporting of global ozone, its vertical, spatial and temporal variations, with sufficient accuracy to detect small but statistically significant long-term trends.

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*See UNEP/WG.7/5 Atmospheric Ozone, a paper submitted by WMO.
**Included between brackets after the heading to each recommendation are the acronyms of first, the lead organization for implementation of the recommendation and second, the cooperating organizations. Where cooperating organizations are not listed the lead organization will make appropriate arrangements for cooperation.

Monitor Solar Radiation (WMO)

2. Design, develop, and implement a system (including appropriate ground-based, airborne and satellite subsystems) for monitoring the intensity and spectral distribution of solar radiation at ground level and extraterrestrially to better understand the formation of ozone, to determine variations of solar flux and to clarify the influence of such variations on the earth's radiation budget and on the interpretation of ground-based measurements.

Simultaneous Species Measurements (WMO)

3. Design, develop, and implement an intensive short-term programme of simultaneous measurements of selected species in the odd-nitrogen, odd-hydrogen and odd-chlorine families to provide a better understanding of the ozone balance and to test the model predictions. This should be supported by a longer term programme on all reactive species including their temporal and spatial variations and base line inventories.

Chemical Reactions (WMO)

4. Design, develop, and implement a broad programme to accurately determine chemical and photochemical reaction rates and quantum yields at appropriate temperatures and pressures; to provide accurate atomic and molecular line strength and location data for use in laboratory and remote sensing measurements of trace species; and to assess the sensitivity of chemical reaction schemes used in atmospheric models.

Development of Computational Modelling (WMO)

5. Develop a hierarchy of improved (1-D, 2-D, 3-D) computational models by which the interrelationships of chemical, radiative, hydrodynamic and thermodynamic processes controlling the troposphere and the stratosphere in both their natural and perturbed states, may be established.

Large-Scale Atmospheric Transport (WMO)

6. Undertake studies to better describe and quantify large-scale atmospheric circulation and transport. Particular emphasis should be given to representation of vertical transport and transfer between the troposphere and the stratosphere.

Global Constituent Budgets (WMO)

7. Develop a much improved understanding of the budgets of atmospheric constituents which affect the ozone balance, including their sources and sinks. At present this should give particular emphasis to the chlorine and nitrogen systems.

2. The Impact of Changes in the Ozone Layer on Man, the Biosphere and Climate

A prediction of depletion of ozone and increased UV-B due to man's activities would have little meaning unless it could be shown, at least qualitatively, that it would have significant effects on man and his environment.

It has been demonstrated that excessive exposure to ultraviolet radiation at 254 nm (radiation of a shorter wave-length than the UV-B which reaches the ground) causes tumors in laboratory animals and has deleterious effects on certain plants. Extensions of the studies to that part of the UV-B band from 290-320 nm have been made by theoretical and experimental work and by a series of epidemiological studies. There is some evidence that increased UV-B would be associated with an increase in skin cancer and possibly in eye damage in susceptible sections of the human population. It is also likely that large increases in UV-B would cause biological damage including damage to nucleic acids and proteins and thereby have deleterious effects on terrestrial and aquatic communities, but the effects of smaller changes in UV-B are highly uncertain because of the capability of biological systems to compensate, to a certain extent, for harmful influences. Although it is clear that significant progress has been made in a wide range of related research activities in the biological and medical sciences there are still many gaps in our knowledge of the effects of increased UV-B. Other effects of modification of the ozone layer, eg. climatic effects might be relavent for the biosphere. The problem being extremely complicated, research results are not yet accurate enough to indicate the possible nature to these effects.

Recommendations:

A wide variety of investigations of the impact of ozone layer modification and increased ultraviolet radiation (UV-B) on man, the biosphere and climate should be encouraged, supported and coordinated. Specifically it is proposed that action be undertaken to:

1. UV Radiation

(i) Monitor UV-B Radiation (WMO/WHO, FAO)

Monitor as far as possible, using best available technology, the spectral distribution and intensity of the UV-B radiation at the earth's surface. This should be done for at least a complete solar cycle at globally distributed sites (and where possible at stations where ozone is being measured and/or skin cancer data being collected and/or plant effects being studied).

(ii) Develop UV-B Instrumentation (WMO, WHO, FAO)

Develop improved instrumentation and methods, including improved artificial sources, for measuring and providing precise levels of UV-B irradiance (both broad-band and narrow-band).

(iii) Promote UV-B Research (WMO, WHO, FAO)

Develop standardized methodologies for conducting UV-B research. Promote investigations to enable a better understanding of the spectral distribution of UV radiation, effects of flux, and effects of factors other than ozone such as atmospheric conditions, ground albedo, etc., in determining the amount and wavelength of UV reaching the ground.

2. Human Health

(i) Statistics on Skin Cancer (WHO)

Obtain improved worldwide statistics of skin cancer incidence and analyze such data in relation to latitude (with particular emphasis on locations where UV and total ozone can be measured simultaneously), types of cancer, age of onset, morbidity and mortality rates, location of cancer on body, sex, degree of skin pigmentation, genetic and ethnic background, occupation and lifestyle. Develop internationally agreed upon protocols for design, collection and analysis of skin

cancer data and develop improved data storage, retrieval and dissemination mechanisms.

(ii) Research on Induction Mechanisms (WHO)

Conduct experimental and theoretical studies at the molecular, cellular, and tissue levels of the mechanisms of damage of UV-B including induction of skin cancer, skin aging, eye damage and possible effects on DNA as functions of dose, dose rate, and wavelength, with attention to possible repair mechanisms, synergistic and antagonistic factors including other wavelengths.

(iii) Other Health Aspects (WHO)

Study potential impact of increased UV-B on aspects of human health other than skin cancer; develop a model for predicting human photobiological response for various skin types, genetic and ethnic background and environmental factors; and conduct research and modelling on the mechanisms of Vitamin D production and effects.

3. Other Biological Effects

(i) Responses to UV-B (FAO)

Conduct studies on the physiological, biochemical, and structural responses, as exemplified by changes in photosynthesis and nitrogen fixation, to increased UV-B radiation of selected native and agricultural plants, animal species, and microorganisms and to develop predictors of UV-B sensitivity. These should emphasize dose-response, reciprocity, synergisms, antagonisms, action spectra and interactions of UV-B and other stress factors on these organisms.

(ii) Terrestrial Ecosystems (FAO)

Study the effect of changes of UV-B radiation on terrestrial

ecosystems (both agricultural and natural) inter alia by means of modelling studies of the impacts of UV-B radiation.

(iii) Aquatic Ecosystems (FAO)

Study the effect of changes of UV-B radiation on aquatic plants and animals emphasizing those related to primary productivity in the oceans; develop improved measurements of UV-B penetration into aquatic environment and study its effects on plankton.

(iv) Other Agricultural Effects (FAO)

Study the effects of changes of UV-B radiation on the stability of agricultural chemicals and the resulting impacts on crop yields and agricultural chemical usage patterns.

4. Effects on Climate

(i) Development of Computational Modelling (WMO)

Further develop modelling capability to assess the effects of ozone changes and also those of CFMs and other compounds with similar effects on the earth's radiation balance and the global climate. A data base for testing such models should be provided.

(ii) Regional Climate (WMO)

Conduct research on regional climate and its variability to provide better evaluations of the effects of the above changes on critical climatic regions.

3. Socio-economic Aspects

To provide a more useful contribution to policy formulation, the assessment of a potential environmental hazard should include not only an evaluation of its costs and benefits to society but also the costs and benefits that would result from a reduction of the hazard. The available data are inadequate to properly assess the socio-economic effects of stratospheric

pollution or of measures taken to control it. Much work has been done on the costs of alternative courses of action particularly with respect to possible limitations on total CFM emissions. However, further elaboration of methodology is needed before a complete evaluation of man-made effects upon the ozone layer can be made at the desirable level of confidence.

Recommendations:

Studies of the socio-economic impact of predicted ozone layer depletions and of alternative courses of actions to limit or control identified ozone-depleting emissions to the atmosphere should be supported at the national and international level. Specifically it is proposed that action be undertaken to:

1. Production and emission data (UNEP, ICC, OECD, ICAO)

Obtain more detailed data on man's present and projected activities in and near the stratosphere and on global production, emission and use of substances that have the potential to affect stratospheric ozone. These data are required to model stratospheric changes as well as to evaluate socio-economic alternatives.

2. Methodology for comprehensive assessment (UNESA, OECD. ICAO, FAO, WHO)

Develop improved methodologies including multidisciplinary systems analysis for assessing the costs and benefits associated with various levels of CFM use, aircraft emissions, use of nitrogen fertilizers and other potential modifiers of the stratosphere, whether controlled or not.

4. Institutional Arrangements

1. The Action Plan will be implemented by UN bodies, specialized Agencies, international, national, intergovernmental, and non-governmental organizations and scientific institutions.

2. The UNEP should exercise a broad coordinating and catalytic role aimed at the integration and coordination of research efforts by arranging for:

- collation and dissemination of information on ongoing and planned research activities
- presentation and review of the results of research
- identification of further research needs
- appropriate encouragement of such research

3. In order for UNEP to fulfill that responsibility it should establish a Coordinating Committee on the Ozone Layer composed of representatives of the agencies and non-governmental organizations participating in implementing the Action Plan as well as representatives of countries which have major scientific programmes contributing to the Action Plan. The Committee should meet with sufficient regularity to meet its reponsibilities. The Committee should be provided with secretariat services adequate to carry out the activities noted in the above section.

The Committee should make recommendations relevant to the continuing development and coordination of the Action Plan to the Executive Director who will report these to the Governing Council.

4. While much of the work included in the Action Plan is being and will be undertaken at the national level, and is the financial responsibility of countries, there is a continuing need for coordination of the planning and

execution of monitoring and research related to particular segments of the Action Plan. This need can most effectively be met by the specialized Agencies as indicated in the recommendations.

5. Each Agency should arrange for the provision of scientific advice relevant to its needs and those of the Coordinating Committee on the Ozone Layer. In addition, the Executive Director of UNEP may from time to time convene a multidisciplinary panel of experts to provide broadly-based scientific advice on the Action Plan.

6. UNEP should consider the need for and feasibility of establishing special coordinating mechanisms or procedures for certain areas of interdisciplinary research included in the recommendations, such as photobiology, which presently lack such coordinating facilities.

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